The effect of using a fried rice machine on product effectiveness and productivity

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Abstract. In general, fried rice is a dish that is popular with the public, conventionally prepared using a set of conventional equipment with problems: (1) its operation requires a lot of physical effort, is tiring and sweaty, not intensive, (2) the equipment is relatively unhygienic, the quality of the results is less stable. The SEGORO fried rice-making machine is the solution to this problem. The SEGORO fried rice unit consists of: a set of heaters with gas energy, equipped with an electric fire starter, a 12 Volt DC motor that drives the stirrer and rotates the Wok, equipped with a relevant wok, equipped with a gas handle valve. Analysis results: (1) one processing batch for 15-20 portions; (2) processing time from 12 minutes to 7 minutes, productivity increased up to 2x; (3) conventionally workers work tiringly and produce a lot of sweat. 'SEGORO' fried rice machine, equipped with an electric stirrer motor and Wok turning motor does not require high physical effort, and is not tiring. In conclusion, the Segoro fried rice machine uses little electricity, low voltage, saves gas and physical energy, its operation is driven by a stirrer motor, and is equipped with a wok turning motor whose speed can be adjusted. The Segoro fried rice machine is made from stainless steel 304, it is more hygienic and meets food-grade standards, and the quality of the processed product is more stable.

1 Introduction

From the many foods spread throughout Indonesia, the majority of the country's population. This makes rice a staple food. One of the processed foods made from Rice is the most popular and sold by MSMEs, street vendors, and restaurants namely fried rice. Making fried rice still requires skill basic hands, a long time, and a lot of energy.

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1.1 Background

In the cooking process, especially in the manufacture of food that involves manual steps such as fried rice, several problems arise in traditional methods that can impact the efficiency and quality of the final product. The manual method of making fried rice generally involves intensive work and requires considerable physical effort. The following are some of the problems encountered in the manual method: (1) Worker fatigue: The manual method of making fried rice tends to require a lot of hand and physical movement. This can cause workers to experience high levels of fatigue. Excessive fatigue can reduce worker productivity and even impact their welfare; (2) Long Time: Because the manual method still relies on conventional equipment and steps are carried out sequentially, the time needed to complete one fried rice order can be longer. This can affect kitchen efficiency and customer service time; (3) Poor Quality of Food: Fatigue experienced by workers can have an impact on the quality of the food produced. Especially when workers sweat, sweat dripping onto pans or equipment can affect the temperature and quality of the food produced. This can reduce the taste and final quality of the dish served; (4) Lack of Cleanliness and Hygiene: The manual method of making fried rice tends to make the ingredients come into contact with workers' hands more often. This can cause hygiene and hygiene problems, as there is a risk of transferring microbes from workers' hands to the food being processed. Lack of hygiene in the cooking process can threaten the health of consumers; and (5) Varied Order Levels: In a restaurant or food stall environment, order levels can fluctuate rapidly. Workers often have to handle large volumes of orders in a short amount of time. This can overwhelm workers and lead to reduced efficiency and increased risk of misrepresentation.

Therefore, there is a need to consider using more efficient, hygienic, and ergonomic methods in the fried rice process to overcome the problems described above. Modern methods or the right tools can help increase productivity, quality, and worker welfare as well as maintain higher standards of hygiene in the cooking process. The SEGORO, an innovative semi-automatic fried rice machine can produce high-quality products and answer the problems above. In addition, the purpose of creating this machine innovation is to make it easier to make rice that requires a frying process, register product certification and quality management so that it is ready for commercialization, share knowledge and information on fried rice-making machines, and be able to improve services to the community so that income increases.

1.2 Previous research

1.2.1 Stirring automatic

In a study on [1] the effect of different stirring speeds on acid refolding of rice glutelin, researchers found that 1% (w/v) rice glutelin hydrocolloid throughout the acidification process. A significant decrease in the size of hydrated rice glutelin particles was observed when the stirring speed was increased to 750 rpm, while further increasing the speed had no significant effect on the particle size. Samples stirred at 750 rpm showed the highest solubility, and samples stirred at 0 rpm showed the lowest solubility. Furthermore, both surface hydrophobicity and molecular weight initially increased and then decreased, reaching a minimum value for the sample stirred at 750 rpm. Principal component analysis (PCA) was used to identify the correlation between changes in different properties such as solubility, particle size, β-sheet content, surface hydrophobicity, and zeta potential and different agitation treatments. In summary, the selection of stirring speed significantly influences various aspects of the refolding process of rice glutelin during acidification. Therefore, selecting the appropriate stirring speed is important to maintain quality control in the production of protein hydrocolloids.

Huber et al. [2], showed the possibility of achieving a more uniform distribution of U-235 enrichment in downblend castings by using zirconia crucibles instead of graphite crucibles. Using graphite as a container, the electromagnetic field generated by the induction heating device interacts directly with the graphite. Zirconium oxide, on the other hand, is not conductive in this situation and therefore does not interact with the field. The induced field interacts directly with the metal, creating electromagnetic stirring (EMS) within the molten metal bath. The results showed that the enrichment uniformity of castings using zirconia crucibles was approximately 8 times better than that of castings using graphite crucibles, as measured by plate enrichment area and coefficient of variation of enrichment.

Based on the study of using a catalytic micromotor as a self-stirring microreactor for efficient dual-mode colorimetric detection [3], we successfully developed a colorimetric detection system using a catalytic micromotor (MIL-88B @Fe3O4). With responsive rotational motion and excellent catalytic performance, this new catalytic MOF-based micromotor not only opens a new dimension of nanotechnology in colorimetric analysis, but also has applications in precision manufacturing, biomedical analysis, environmental management, etc. It shows great potential in various fields. These micromotor-based microreactors can be easily used for various chemical microreactions in various applications.

Based on a study focused on parametric optimization and experimental validation of multiple fertilizer mixing using air bubbles and knife stirring [4], and a study based on discrete element simulation, multiple fertilizer mixing was performed to improve overall utilization. The goal is to improve the uniformity of the fertilizer mix. The simulations were performed using his EDEM and Fluent software, and the results were confirmed by experiments. Simulation results show that the ideal mixing speed range for individual blade groups is 600 to 900 revolutions per minute (r·min-1), with the best mixing when the blades are positioned at an angle of 20 degrees (α). It shows that uniformity is achieved. Bench test results show that the mixing uniformity of air injection and double knife stirring is better than the double knife group, and the double knife group is better than the single knife group, which is consistent with the simulation results. Moreover, the deviation between the experimental and simulated values is in the range of 2%, confirming the reliability of the simulation model. The results of this study serve as a valuable reference in the design of variable-speed fertilizer mixing equipment.

Based on research [5] pertaining to the proposal of a novel method for creating continuous rheological materials utilizing rotating barrels equipped with stirred screws and the subsequent evaluation of their microstructure, a fresh process for fabricating rheological materials has been introduced. This innovative method employs specialized rotational barrel-type equipment designed for use in rheo die-casting and rheoforming processes.

The specially designed rotational barrel-type equipment has the unique capability of producing rheological materials continuously while also offering control over shear rate and temperature. The findings suggest that as the rotation speed increases, the rotation time lengthens, and the cooling rate decreases, the equivalent diameter and roundness of the primary particles become smaller. However, it has been verified that grain agglomeration and an increase in grain size occur when the rotation time exceeds 1800 seconds.

This study presents a new thermo-solid model based on the work on a thermo-solid coupled model [6] that simulates the heating and agitation of particles in a rotating drum using disk discontinuous deformation analysis. This model combines Discontinuous Deformation Analysis (DDDA) and Discrete Thermal Element Method (DTEM) and is called the DDDA-DTEM model. Its purpose is to reproduce the process of heating and stirring particles in a rotating drum. The results show that a rotation speed of 15 revolutions per minute (RPM), 2 to 6 medium stirring blades, and a load rate of 20% are helpful in achieving high-quality processing results. The model performance shows that the DDDA-DTEM model established here serves as a viable tool for simulating the heating and stirring of particles in a rotating drum. This is of great importance in refining granular material processing strategies and industrial plant designs.

In light of research [7] focused on utilizing ultrasound to create gluten-free dough for automated dumpling production, it's important to consider the growing prevalence of celiac disease. Celiac disease is an autoimmune genetic condition that leads to intestinal damage as a reaction to specific proteins in the diet. Individuals with celiac disease must avoid foods containing gluten, such as dough made from grains containing this protein. Unfortunately, gluten-free dough typically exhibits subpar rheological properties and is unsuitable for the automated shaping of dumplings. This article introduces an innovative approach, combining ultrasonic technology with gluten-free dough preparation to enhance its rheological qualities, making it suitable for the automated dumpling molding process.

The application of ultrasonic treatment, specifically at a 35 kHz frequency, plays a pivotal role in homogenizing the dough's structure and modifying its rheological characteristics. Sonication results in a twofold increase in dough volume and subsequently enhances dumpling mass yield by 2 to 10% per kilogram of dough. Beyond the economic benefits, this technology also provides an added sterilization effect during dough preparation.

Based on research [8] conducted on the creation of a real-time automated citrus fruit sorting device, this machine is meticulously designed and utilizes a computer vision-based adaptive deep learning model for optimal performance. Traditional automation methods for postharvest tasks often suffer from time and data inefficiencies, resulting in less-than-optimal outcomes. These automated systems typically necessitate the involvement of highly skilled software experts for calibration and reconfiguration, which can inflate costs significantly.

In this study, modern sensors and intelligent devices capable of conducting deep learning image analysis have been harnessed to design automated machines for postharvest operations, including washing, vision-based sorting, and weight-based grading of citrus fruits. This approach minimizes the need for human intervention and significantly reduces attrition, while achieving outstanding performance in executing specific tasks. The accuracy of the machine's performance is ensured through the use of optimal mechanical component design, which is achieved through kinematic synthesis and dimensional analysis.

Based on the research [9] conducted to develop an automated pest monitoring system for rice fields using machine vision, it is essential to effectively implement integrated pest management. Light traps are widely used around the world for pest monitoring in the agricultural field. This paper introduces the development of an automatic monitoring system for pests captured in rice light traps using image processing technology. To prevent the accumulation of captured insects, a vibrating plate and rotating conveyor belt are used to disperse the insects. This study shows a strong correlation (r=0.92) between automatic and manual identification methods based on daily pest counts from single light trap images over a one-year period. Field experiments highlight the effectiveness and accuracy of automatic light trap monitoring systems.

Built upon research [10], this study concentrates on creating and assessing an automated control system for rice polishing machines that utilizes computer vision and fuzzy logic. The main goal is to establish an intelligent Automatic Control System (ACS) that utilizes machine vision and fuzzy logic methods to regulate rice polishing machines. The evaluation results show that the developed ACS can accurately determine the desired operating conditions of the polishing machine with an accuracy rate of 89.2%. On average, each monitoring cycle takes approximately 14.73 seconds, with 6.4 seconds for kernel sampling and transportation into the imaging chamber, 7.33 seconds for capturing three kernel images, image processing, and running the fuzzy inference process, and the remaining 1.5 seconds dedicated to pressure level adjustments within the mechanism.

Based on research [11] focused on the development of a control system for automatic mini plug seed planting machines, the context in China's vegetable production landscape primarily revolves around small and medium-sized farms, rather than traditional open field cultivation. These facilities often contend with low ceilings and limited dimensions, making it challenging to employ planting machinery. Consequently, many vegetables farmers resort to manual planting due to these spatial constraints. To address the automation needs of small and medium-sized agricultural setups, a compact, remote-controlled, wireless automatic planting machine was conceived. This device can swiftly transplant seedlings within greenhouses while also prioritizing environmental sustainability. It leverages wireless communication to govern all of its operations. Within the agricultural production process, the control system of agricultural machinery plays a crucial role in determining the level of automation. Therefore, this study focuses on designing an innovative control system for the automatic planting machine. The control system hardware is divided into three essential components: sensors for signal collection, programmable controllers for signal processing, and actuators for specific actions.

Based on research [12] focused on the supervisory control of automatic pouring machines, this paper introduces a supervisory control approach for an entire molten metal pouring system aimed at enhancing plant productivity, ensuring worker safety, and improving product quality. The process involves the use of a pouring process model to calculate the forward tilt control input using an adaptive feed-forward control system. This input is designed to maintain a consistent liquid level in the sprue cup while accounting for variations influenced by the build-up of slag in the ladle.

The back tilt input is determined through a hybrid shape approach applied to mitigate the tilting action. The supervisory control system smoothly transitions from forward tilting to backward tilting by employing model predictive control to achieve precise control over the quantity of the pour. Experimental tests validate the effectiveness and practicality of the proposed comprehensive control system.

Based on a study [13] focused on reducing pressure drops in the design of spiral impeller static mixers through additive manufacturing, a novel static mixer design referred to as the SSM Impeller has been introduced. Experimental measurements of pressure drop and mixing characteristics were conducted and subsequently verified through computational fluid dynamics (CFD) analysis. The study examined five different SSM Impeller designs, each featuring variations in taper, discharge, and attack angles. In comparison to a standard SSM of equivalent size, the SSM Impeller demonstrated a reduction in pressure (and power) of up to 18.2%. These reductions have the potential to yield substantial energy savings and allow for downsizing in industrial applications employing static mixers. Moreover, the experimental results underscore the capability of additive manufacturing to produce custom SSM Impellers without the need for costly machining and joining methods.

In a study [14] concerning counter-current mixer-settler chromatography utilizing a spiral disk assembly modified with glass beads as barriers, a novel spiral disc design was developed. This design involved the strategic placement of barricades at 6 mm intervals along the central spiral channel to partition it into discrete sections. Within alternate sections, glass beads were introduced, promoting a planetary motion that led to repeated mixing and deposition of the polymer phase system. The efficacy of this spiral disc assembly within the mixer-settler setup was evaluated in the context of separating lysozyme and myoglobin using a polymer phase system. The most favorable outcomes were achieved when employing spiral discs equipped with barricades featuring openings ranging from 1.2 to 0.4 mm on each side, especially at high rotational speeds of up to 1200 rpm.

1.2.2 Stainless steel 304 food grade

According to research [15] that investigated the effect of allium extract inhibitors on the localized corrosion behavior of 304 stainless steel through electrochemical noise analysis showed that adding the inhibitor up to the optimum concentration (8 cm^3 L^{-1}) was effective. Improvements increase immunity to spectral noise. Shot noise results show that in the presence of Allium Sativum (garlic) inhibitor, the frequency distribution of events shifts to a higher frequency range, indicating reduced localized corrosion of stainless steel. Analyzes of hole formation and hole growth showed that although the antioxidant properties of allium extract increased the hole formation rate, the formation of stable holes with a radius greater than 30 μm was significantly reduced due to metastable hole filling. It became clear that it had been thwarted. Phosphate compounds. Microscopic examination of the corrosion morphology supported the hypothesis that phosphate compounds formed within the pit core and the steel surface was subsequently repassivated.

In a study entitled "Exploring surface topographical properties and bacterial adhesion: a case study investigating the adhesion of Listeria monocytogenes scotia on type 304 stainless steel" [16], using a type 304 stainless steel surface, A detailed investigation was carried out and the aim of the study was to determine the differences in bacterial adhesion to this particular material by examining two common surface types: extrusion and soil. This study involved investigating 15 surface topography parameters at three different processing temperatures and identifying possible relationships between these parameters and microbial attachment on these surfaces. To achieve this, the surfaces were analyzed qualitatively and quantitatively using a variety of techniques, including scanning electron microscopy, energy-dispersive X-ray spectroscopy, and confocal microscopy. Using statistical techniques such as analysis of variance and multivariate regression analysis, L. Monocytogenes on stainless steel surfaces Scott A. The results showed that there is a strong correlation between bacterial adhesion and surface properties, especially surface isotropy, average surface roughness, surface spacing, and processing temperature in the case of 304 stainless steel material.

Drawing from research on [17] stainless steel corrosion within the food and pharmaceutical sectors, stainless steel finds extensive application in these industries, primarily owing to its exceptional resistance to corrosion and its superior mechanical attributes. These attributes hold immense significance since the substances utilized in food and pharmaceutical manufacturing must adhere to stringent purity and quality standards. The prudent selection of an appropriate stainless steel grade plays a pivotal role in averting corrosive occurrences that can have adverse repercussions on the overall production processes. In this discussion, we will delve into an examination of the stages within the food and drug production procedures, with a specific focus on potential corrosion mechanisms affecting stainless steel under specific operational conditions.

2 Methods

This method uses reverse engineering, then is registered for certification and commercialized. This design emerged based on the background of existing problems and was supported by several supporting literature so that a suitable design concept was obtained to solve the problem. Then make working drawings of several components and determine the tools according to the design. After that, prepare to make tools. The steps are to create a framework, and then the process of making tools and tool systems. After going through this, a trial is carried out to determine whether the tool works according to the research objectives or not. If it meets the research objectives, research results and data can be obtained so that the performance of the SEGORO machine can be analyzed whether it is running effectively or not. Then conclusions can be drawn based on the data that has been found, then submitted to small and medium businesses, then the tools are implemented for the performance of small and medium businesses and the research is completed. The research flow can be depicted in Fig. 1 below.

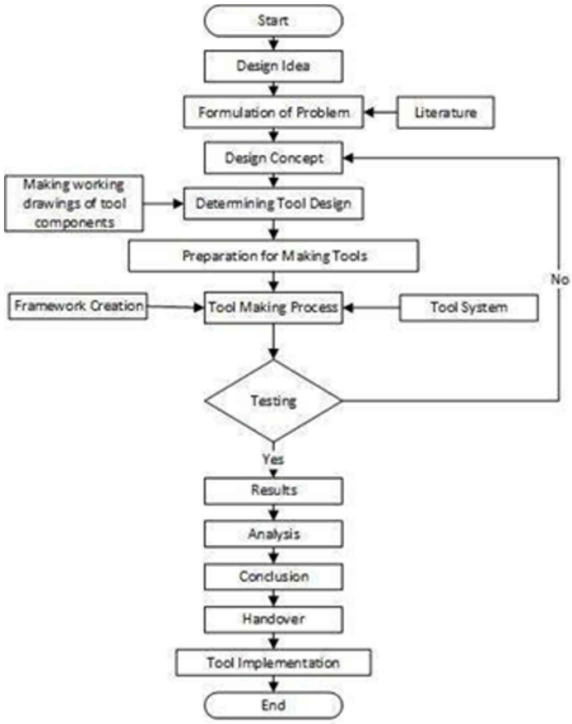

Fig. 1. Research Flow of Segoro Machine

This research compares cooking fried rice with a fried rice machine and conventional methods in 15 portions/batch. This research aims to find out the comparison of cooking fried rice using a fried rice machine and conventional methods.

3 Result and discussion

3.1 Engine specification

The SEGORO machine has been created based on analysis and working drawings. Based on the working drawings, a prototype is then created. The specifications for the fried rice machine are in Table 1 below.

Table 1. The SEGORO fried rice machine specifications

Aspect	Information
Ingredients	Stainless Steel 304 standard Foodgrade
Dimension	80 x 70 x 70 cm
Corner turning drive	Motor wiper
Shape of stirrer,	The shape of the stirring tool, spiral with medium - large - medium sizes in harmony with the curved surface of the wok
The stirring tool speed	Can be adjusted according to needs
Stove	Type 203 Burner Size 9cm
Wok dimension	Diameter 50 cm
Capacity	15-20 portion/ batch
Stirring rotation speed	30 rpm (can be adjusted according to needs)
Distance between stove and bottom wok	5 cm
be equipped	fire protection device from wind
Power	100 watt

The SEGORO fried rice machine has several components: (1) a stove set equipped with a gas valve handle to regulate the size of the fireplace; (2) one unit of spiral-shaped stirrer whose curve is adjusted to the curve of the Wok surface. On the mixing spiral, there are 8 pairs of tools for breaking down rice chunks 'resembling two fingers' (specially designed). For operation, it is equipped with a stirring speed control device; (3) the driving motor is a 12 V DC motor that is used to drive the stirrer and rotate the Wok electrically (semi-automatically); (4) The wok is equipped with 4 hooks to maintain its stable position during the process. With the operation of all these components, it is capable of maximizing the process of breaking down rice grains and mixing spices more quickly. This way it does not require a lot of physical effort, and you can even do other work, for example, tidying and cleaning the work area. The SEGORO fried rice machine is made from stainless steel (SS) 304. SS 304 is a type of food-grade stainless steel, easy to shape and resistant to very high corrosion, the surface of SS 304 is straight and not wavy, easy to clean. The working drawing of the fried rice machine can be seen in the following image (Fig. 2).

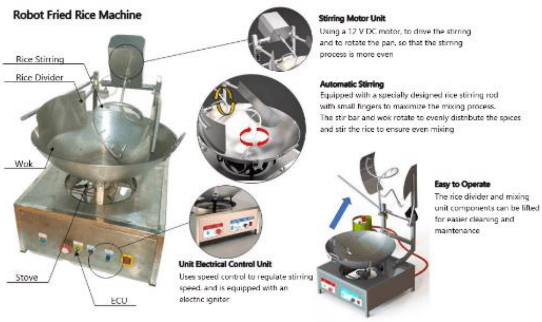

Fig. 2. Design model for the fried rice-making machine

The spiral stirrer has claws for scraping the rice at the bottom of the pan so that it is mixed perfectly and completely, with a length of 5 cm and an angle of 90°. The claw image can be seen in detail in the image below (Fig. 3).

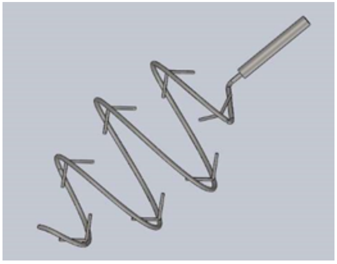

Fig. 3. The claw of stirring SEGORO Machine

3.2 Result

The comparison results of testing the fried rice machine with the conventional method can be seen in Table 2.

Table 2. The comparison results of testing the fried rice of conventional method with the fried rice by Machine (the SEGORO)

Based on Table 2. 1500 grams of rice with a gas requirement of 80 grams, the quality of the rice grains is crushing chunks of rice is more difficult, requires a lot of energy, takes longer, leaving a few pieces of rice, and produces 15 servings in one cooking process in 12 minutes. Meanwhile, trial II with a quantity of 1500 grams of rice and a gas requirement of 70 grams showed that the quality of the rice grains was crushing chunks of rice is easier, doesn't involve much human effort, the rice grains are split evenly, and the time required to cook the fried rice was 7 minutes to produces 15 portion/ batch. In terms of effectiveness, cooking large portions of fried rice is more effective using a fried rice machine compared to conventional methods.

Information	Test I (Conventional)	Test II (with the SEGORO)
Amount of rice (gr)	1500	1500
Gas requirements (gr)	80	70
Rice quality	Crushing chunks of rice is more difficult, requires a lot of energy, takes longer, leaving a few pieces of rice.	Crushing chunks of rice is easier, does not involve much human effort, the rice grains are split evenly.
Taste and color	Uneven	Equally
Time (minutes)	12	07
Physical load (interview and observation results)	The perpetrator (student) feels tired, his face shows tension (serious)	The perpetrator (student) feels relaxed, his face shows relaxation and he can tidy up his work desk

Fig. 4. Cooking with conventional methods

Figure 4 shows the conventional cooking process for fried rice. Throughout the processing process, physical effort is required to crush the rice chunks and mix the rice with the spices. From the beginning to the end of processing, workers continuously do physical work. Apart from that, the spatula used is made from 304 stainless steel which is quite heavy, thus adding to the load in the continuous stirring process. The time required is relatively long, namely 12 minutes. The processed rice grains have not been completely decomposed, there are still some lumps of rice (small lumps).

Fig. 5. Cooking with the SEGORO machine

In Figure 5 the cooking process with the SEGORO fried rice machine. At the beginning of the process, stirring the eggs is done manually, then after the rice is added, the stirring is done with a semi-automatic stirrer which has been specially designed and with the Wok rotating at medium rotation. Crushing chunks of rice is done more easily, very little physical effort is required, and the grains of rice are split evenly. The overall quality of the processed product shows that the color of the rice shows that the spices and rice are mixed very evenly throughout. Overall, 15 portions are prepared in 7 minutes. The equipment is easy to clean.

3.3 Discussion

3.3.1 Stirring Machine Automatic

This SEGORO machine is a semi-automatic mixing machine with 100 watts of power for cooking fried rice in large portions, where one cooking process produces 15 portions. This machine is equipped with a spiral stirrer with a claw length of 5 cm and an angle of 90◦ with a pan diameter of 50 cm so that it can accommodate large portions.This way it doesn't require a lot of physical effort, and you can even do other work, for example, tidying and cleaning the work area. The time needed to start heating the pan is no more than one minute so the cooking process is very short for large portions, namely 7 minutes. This machine can cook to the bottom of the pan so it can cook optimally with even taste and color and the rice grains remain intact. For a more detailed machine design, see the following image (Fig. 6).

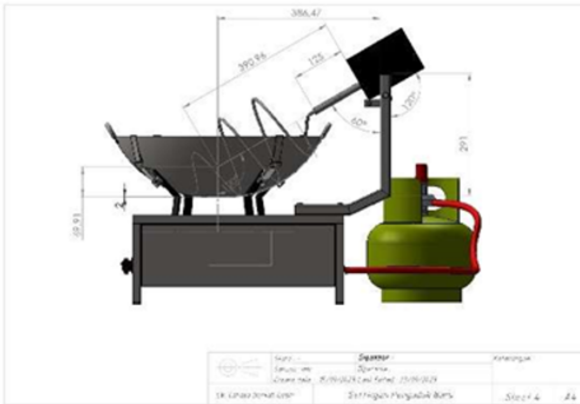

Fig. 6. Detailed SEGORO design

Based on the research that has been carried out, it can be concluded that the SEGORO machine is very effective for use in cooking large portions and is also very good for reproduction and commercialization. This is in line with research [1]. Research for automatic rotation mixers was obtained from research literature [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12]. The spiral stirrer research is in line with research [13] and [14].

3.3.2 Stainless steel 304 food grade

This SEGORO machine is easy to operate from preparing the equipment to starting cooking, which takes 7 minutes. This machine is very easy to clean and rust-proof because it uses food-grade 304 stainless steel. The 304 stainless steel material can be proven in research [15], [16], and [17].

4 Conclusion

Using a fried rice machine can speed up the frying process from 12 minutes to 07 minutes/batch (15 portions) so that productivity can be increased up to 2x. The Segoro machine only uses a small amount of electricity with low voltage and saves gas usage. Apart from that, it can save energy so it doesn't get tired easily because it is done by machine, the product is more hygienic because the machine material is made from food grade standards, namely stainless steel 304, the quality of the processed product is more stable.

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